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Busk, Louise L.; Dufva, Martin

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

DTU Nanotech
Department of Micro- and Nanotechnology

Cheap fabrication of solid phase droplet microfluidics chips for single molecule studies

Louise L. Busk, Martin Dufva - Dept. of Micro- and nanotechnology, Technical University of Denmark, 2800. Kgs. Lyngby

Introduction

Microdroplet arrays are used for compartmentalization of biochemical reactions. They enable single molecule detection with great sensitivity[1], which is particularly interesting in e.g. molecular diagnostics[2] and high-throughput screening. The availability of such platforms depend on price and ease of fabrication. Here, we present an easy to fabricate hydrophilic in hydrophobic droplet array chip for less than $10 per chip.

Properties of FluorAcryl 3298

CYTONIX FluorAcryl 3298 is a negative tone, hydrophobic photoresist based on fluorinated acrylate. The contact angle with water was measured to be 100° after UV curing and development (Figure 1). FluorAcryl 3298 is photopatternable through standard photo-lithographic methods. Besides being hydrophobic and oleophobic, FluorAcryl 3298 has good chemical resistance and is anti-fouling.

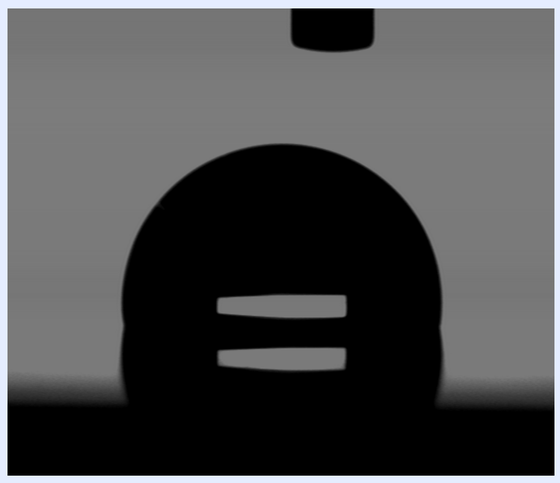

Figure 1: Photograph of a 2 µL droplet on FluorAcryl 3298 taken using a drop shape analyzer. The contact angle is measured to be 100°.

Fabrication of microdroplet arrays

Microdroplet arrays were produced by spin coating a thin film of FluorAcryl, then, the solvent was evaporated by heating the wafer to 80°C. Masked UV exposure produced a pattern in the FluorAcryl film, visible after dissolving the uncured resist in either ethyl acetate or butyl acetate (see Fig. 2).

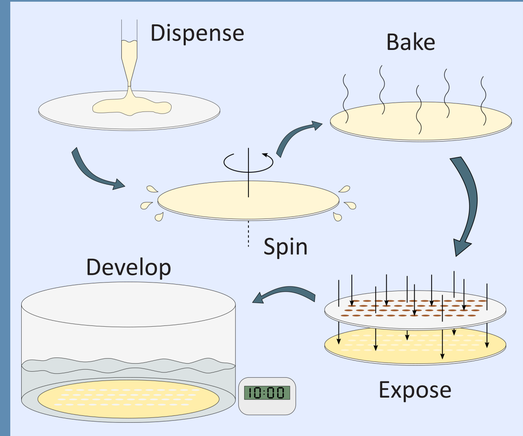

Figure 2: Fabrication steps for making FluorAcryl arrays on glass wafers

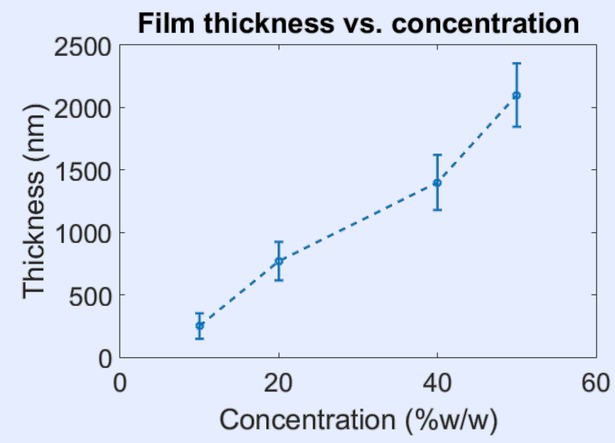

Figure 3: Film thickness vs. FluorAcryl concentration (30 s at 3000 rpm). Error bars represent std (n=3).

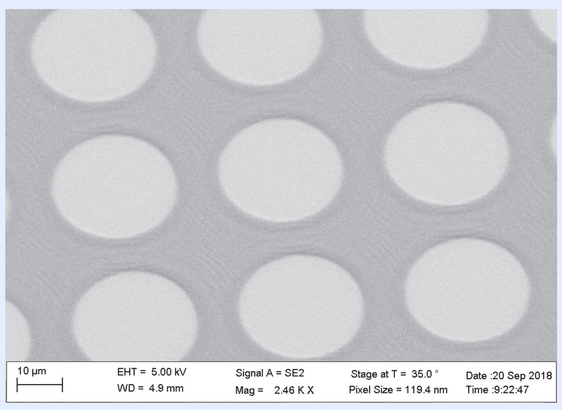

Figure 4: SEM micro-graph of 25 µm in diameter holes in a 175 nm thick film of FluorAcryl

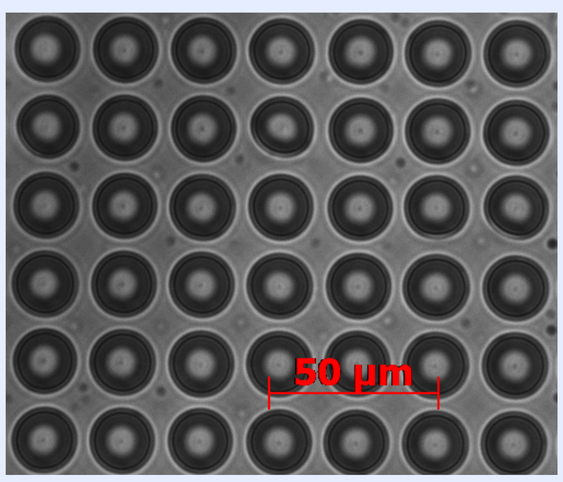

Figure 5: Aqueous droplets 25 µm in diameter on patterned Fluor-Acryl.

Results

The thickness of the FluorAcryl film was primarily dependent on the concentration of FluorAcryl when spin coating the wafer. Dilution in ethyl or butyl acetate to between 10 and 50 %w/w produced films 200 to 2000 nm thick measured using a stylus profilometer (see Fig. 3). SEM inspection (see Fig. 4) in combination with topological measurements using a stylus profilometer revealed that photo patterning was complete, and microscope images of aqueous droplets supported this (see Fig 5).

Conclusion

FluorAcryl 3298 has advantageous properties for fabricating microdroplet arrays. Other fluorinated polymers has been used for this purpose[3], however at a much higher price. Here we have shown that FluorAcryl 3298 is photopatternable using a single step lithographic process, and that arrays fabricated in this manner can support aqueous droplets.

[1] Y. Rondelez et al., Nat. Biotech., 2005, 23(3), 361-365
[2] D. M. Rissin et al., Nat. Biotech., 2010, 28(6), 595-599
[3] R. Iino et al., Lab Chip, 2012, 12, 3923-3929

Contact me

E-mail: mallbu@nanotech.dtu.dk

Dept. of Micro- and Nanotechnology
Technical University of Denmark
2800 Kgs. Lyngby

www.linkedin.com/in/louiselaubbusk